COMPARATIVE ANALYSIS OF THE 2019 RESULTS BETWEEN JUNIORS AND SENIORS IN WOMEN'S ARTISTIC GYMNASTICS AT THE WORLD CHAMPIONSHIPS

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Abstract

The subject sample was composed of (n=259) gymnasts who competed at the 49th FIG WAG Artistic Gymnastics Senior World Championships Stuttgart (GER) and (n=119) gymnasts who competed at the 1st FIG WAG Artistic Gymnastics Junior World Championships Gyor (HUN). The aim of this study was to determine the differences between the two age groups of gymnasts (juniors and seniors) in all the predictor variables by analysing the D, E and FS score. Difference between juniors and seniors is 5.474 years of age. In individual competitions there is no difference in qualifications between BBE, FXE, FXF and in the finals: VTE, UBE, BBE, BBF, FXF. In team competition, the highest scores are on the VT and the lowest on the BB. In all-around competitions there is no difference in qualifications between UBE, BBD, FXE, FXF, FS and in the finals: UBE, FXE. Average FS scores on vault are significantly higher than on all other apparatus.

Key words*: Artistic Gymnastics; World Championship; Women's; Comparation, Judging*

Introduction

Artistic gymnastics is a typical multidisciplinary sport with four disciplines in women's: Vault (VT), Uneven Bars (UB), Balance Beam (BB) and Floor Exercise (FX). Women perform at the competition the maximum 8 highest difficulty value (DV) including the dismount are counted on UB, BB and FX. Currently, in the Olympic Games (OG) or World Gymnastics Championships (WCh), the meet is divided into several sessions that are held on different days: Qual = qualification (C-I), AAF = all-around finals (C-II), TF = team finals (C-III) and AF = apparatus finals (C-IV). Code of Points (COP) for the evaluation of the artistic gymnastics includes nine levels of degree of difficulty. The initial degree of severity represents the level A=0.10 points, and the next levels are B=0.20 p., C=0.30 p., D=0.40 p., E=0.50 p., F=0.60 p., G=0.70 p., H=0.80 p. and I=0.90 p. The final one is the greatest degree of severity. The primary purpose of the WAG COP is to "*provide an objective means of evaluating gymnastics exercises at all levels FIG official competitions, assure the identification of the best gymnast in any competition"* (FIG, 2017). In artistic gymnastics, the emphasis is on the aesthetic component, which must be performed in accordance with the conventionally defined movement structure. Although the methods of evaluation in individual sports differ among themselves: either by the number of judges, the criteria set or how the final result is calculated, for individual sports such as: (figure skating, diving, synchronized swimming, gymnastics: *acrobatics, aerobics, rhythmics, trampoline, artistics*, dressage*: gp & gp special and gp freestyle*, ski jumping, freestyle snowboard: *snowboard-halfpipe and slopestyle*, dance, aerials, etc.) it is characteristic that judges evaluate the quality of competitive effects on the basis of the displayed compositions or jumps (Atiković, 2012). Artistic gymnastics is a sport with a primary requirement of adopting the technique of the most varied specific exercises. This means that learning new, more complex and demanding elements is the everyday principle of the training process (Ferkolj, 2010). Properly mastered technique is largely decided on the visual performance efficiency. This means that it often happens that a harmless error in the technique of performing a complex element disparage or even prevents the entire element from being performed (Atiković & Smajlović, 2011). Several aspects of judging performance were already described in the past at various competitions and several propositions for further improvements in this field were made: (Atiković and Smajlović, 2011; Ansorge et al., 1978; Ansorge and Scheer, 1988; Popović, 2000; Ste-Marie, Valiquette, & Taylor, 2001; Plessner and Schallies, 2005; Boen et al., 2008; Čuk and Atiković, 2009; Leskošek et al., 2010; Dallas and Kirialanis, 2010; Bučar Pajek et al., 2011; Bučar et al., 2012; Pajek et al., 2013; Heiniger and Mercier, 2018; Atiković et al, 2020). For the official senior FIG Competitions age of participants for the OG the participants must,

in the year of the competition, have the following minimum age: Seniors Men's Artistic Gymnastics 18 years Women's Artistic Gymnastics 16 years Juniors in Men's Artistic Gymnastics the gymnast must be not less than 14 years of age not more than 17 years. Women's Artistic Gymnastics the gymnast must be not less than 13 years of age not more than 15 years (FIG Technical Regulations, 2019).

Purpose of the study

The aim of this study was to determine the characteristics of junior routines results their differences in relation to senior routines results by analysing the final score (F), achieved at the 2019 World Championships in (Gyor and Sttutgart).

Methods

Subjects and research method

Our sample was composed of (n = 259) gymnasts who competed at the 49th FIG WAG Artistic Gymnastics Senior World Championships Stuttgart (GER) and (n = 119) gymnasts who competed at the 1st FIG WAG Artistic Gymnastics Junior World Championships Gyor (HUN). On some indapparatus, it was a smaller number of gymnast because it comes to qualifying competition where they compete only by specialists on particular apparatus, so the number of gymnasts on individual apparatus is considerably smaller.

Variables

We have made analysis results from the official book results of the Fédération Internationale de Gymnastique (FIG) of female participants in WAG for the period of 2019.

All data for this study was obtained from the website: 1st FIG Artistic Gymnastics Junior World Championships Gyor (HUN) from 27 to 30 june, 2019 https://www.jwchgyor2019.hu/en/ and 49th FIG Artistic Gymnastics Senior World Championships Stuttgart (GER) from 4 to 13 october, 2019 https://www.stuttgart2019.de/en/, and Longines official results books 2019 https://www.longinestiming.com/gymnastics. We made variables of judges E score, D score and F final score (D + E score) from 4 apparatus: Vault (VT), Uneven Bars (UB), Balance Beam (BB) and Floor Exercise (FX).

Statistical analysis and interpretation of data

The data were analysed using the Statistical Package for Social Sciences – version 23.0 (SPSS Chicago, USA) and Microsoft Office Excel 2013. Descriptive statistics were calculated using the mean (M) values as a measure of central tendency, standard deviation (SD) as a measure of dispersion. Five percent level of significance ($p < 0.05$) was considered for all statistic parameters. We used Paired Sample T-Test, to determine whether there were significant differences between the apparatus. At the end we did also factor analysis, we defined important factors. For calculating the chronological age the following formulas from the Microsoft Office Excel 2013 package were used. For the total *number of days* of one's age since the date of birth until the first day of the competition qualifications:

Calculation formula = DATEDIF (A1; B1; "d") (1)

For the total *number of years* of one's age since the date of birth until the first day of the competition qualifications:

Calculation formula = DATEDIF (days x 0.0027397260273973 years) (2)

Results and discussion

Analysing the parameters of the central tendency of minimum and maximum values it can be established that the juniors are on average old (n = 119; M = 14.682; SD = .548) and seniors are on average old (n = 259; M = 20.099; SD = 3.896). The results of independent t test were significant, t test (375) = 15.181, $p < .000$, indicating that there significant difference between juniors and seniors is 5.474 years of age.

The results in (Table 1) of independent t test were no significant, t test in Qualifications BBE ($p < .547$; mean diff .043 p.), FXE ($p < .061$; mean diff .318 p.), FXF ($p < .413$; mean diff .071 p.), and Finals VTE ($p < .216$; mean diff .139 p.), UBE ($p < .306$; mean diff .150 p.), BBE ($p < .658$; mean diff .158 p.), BBF ($p < .242$; mean diff .520 p.),, FXF ($p < .170$; mean diff .304 p.), indicating that there are no significant differences between WAG juniors and seniors 2019 at individual apparatus qualifications and finals results.

Looking at the qualification results, we see that 29 junior teams and 24 senior teams have performed. For juniors the team consists of 4 registered gymnasts, 3 represent the team and the 2 best scores count. For seniors the team consists of 6 registered gymnasts, 5 represent the team and the 3 best scores count. Only the top 8 qualifying teams are eligible to compete in the finals. We are not able to compare the results in the team standings because the number of female competitors is lower in juniors compared to seniors. Only descriptive statistics are presented in the (Table 2). In juniors (M = 26.266; SD = 1.138) and seniors (M = 42.379; SD = 1.146), the VT has the highest average score. It is the same with juniors (M = 24.297; SD = 1.671) and seniors (M = 37.570; SD = 2.235), when it comes to the lowest mean score that is on BB.

Table 1. Individual Apparatus Qualifications and Finals

Apparatus	Category	Qualifications					Finals				
		n	M	SD	p	Mean diff.	n	M	SD	p	Mean diff.
VTD	Juniors	107	4.371	.565	.000	-.344	16	5.062	.363	.000	-.687
	Seniors	206	4.716	.589			16	5.750	.258		
VTE	Juniors	107	4.134	.994	.000	-.506	16	8.881	.267	.216*	-.139
	Seniors	205	4.640	1.017			16	9.020	.350		
VTF	Juniors	108	4.722	.448	.000	-.094	16	13.907	.416	.000	-.800
	Seniors	207	4.816	.624			16	14.708	.412		
UBD	Juniors	108	4.500	.436	.003	-.172	8	5.487	.322	.000	-.775
	Seniors	203	4.672	.509			8	6.262	.219		
UBE	Juniors	107	8.482	.318	.000	.297	8	8.220	.199	.306*	-.150
	Seniors	206	8.779	.338			8	8.370	.345		
UBF	Juniors	107	6.995	1.021	.005	-.336	8	13.708	.472	.002	-.925
	Seniors	205	7.331	.993			8	14.633	.497		
BBD	Juniors	108	6.859	.925	.001	.382	8	5.475	.337	.049	-.375
	Seniors	207	6.477	1.030			8	5.850	.358		
BBE	Juniors	108	7.496	.649	.547*	.043	8	7.799	.675	.658*	-.158
	Seniors	203	7.453	.569			8	7.958	.725		
BBF	Juniors	107	12.830	.716	.000	-.635	8	13.274	.747	.242*	-.520
	Seniors	206	13.465	.799			8	13.795	.945		
FXD	Juniors	107	11.111	1.639	.000	-.840	8	5.175	.190	.006	-.562
	Seniors	205	11.951	1.823			8	5.737	.450		
FXE	Juniors	108	11.570	1.116	.061*	.318	8	8.562	.151	.040	.220
	Seniors	207	11.252	1.561			8	8.341	.231		
FXF	Juniors	108	11.977	.905	.413*	-.071	8	13.699	.315	.170*	-.304
	Seniors	203	12.068	.942			8	14.003	.504		

Table 2. Women's Team Qualification and Finals

Apparatus	Category	Qualifications			Finals		
		n team	M	SD	n team	M	SD
VT	Juniors	29	26.266*	1.138	8	27.264*	.938
	Seniors	24	42.397ˣ	1.146	8	43.482ˣ	.823
UB	Juniors	29	23.759	2.201	8	26.354	1.584
	Seniors	24	40.669	2.364	8	41.265	1.548
BB	Juniors	29	24.297**	1.671	8	26.119**	.944
	Seniors	24	37.570ˣˣ	2.235	8	39.057ˣˣ	1.229
FX	Juniors	29	24.734	1.386	8	26.274	.829
	Seniors	24	38.565	1.630	8	40.319	1.809
FS	Juniors	29	99.058	5.799	8	106.012	3.633
	Seniors	24	159.199	6.480	8	164.124	4.061

The results in (Table 3) of independent t test were no significant, t test in Qualifications UBE ($p < .074$; mean diff .240 p.), BBD ($p < .145$; mean diff .101 p.), FXE ($p < .317$; mean diff .078 p.), FXF ($p < .915$; mean diff .013 p.), FS ($p < .125$; mean diff .840 p.) and Finals UBE ($p < .250$; mean diff .220 p.), FXE ($p < .189$; mean diff .157 p.), indicating that there are no significant differences between WAG juniors and seniors 2019 at all-around qualifications and finals results.

The results are presented in (Table 4) Paired Samples Test of the analysis of the Women's All-Around final score Qualifications and Finals of juniors and seniors. It is evident that one apparatus has the biggest differences compared to all the others. The difference is more than one point (p) for the following apparatus: Qualifications (VTF & UBF = 1.757 p., VTF & BBF = 1.249 p.) and Finals (VTF & UBF = 1.587 p., VTF & BBF = 2.168 p., VTF & FXF = 1.368 p.).

Table 3. Women's All-Around Qualifications and Finals

Apparatus	Category	Qualifications					Finals				
		n	M	SD	p	Mean diff.	n	M	SD	p	Mean diff.
VTD	Juniors	79	4.377	.572	.000	-.280	24	4.850	.450	.001	-.480
	Seniors	173	4.657	.580			23	5.330	.433		
VTE	Juniors	79	8.520	.239	.000	-.238	24	8.595	.342	.000	-.382
	Seniors	173	8.759	.348			23	8.977	.195		
VTF	Juniors	79	12.877	.679	.000	-.509	24	13.433	.563	.000	-.866
	Seniors	173	13.387	.802			23	14.299	.529		
UBD	Juniors	79	4.107	1.062	.002	-.450	24	4.891	.583	.000	-.790
	Seniors	173	4.558	1.037			23	5.682	.434		
UBE	Juniors	79	7.025	1.004	.074*	-.240	24	7.731	.659	.252*	-.220
	Seniors	173	7.266	.981			23	7.951	.640		
UBF	Juniors	79	11.120	1.699	.005	-.678	24	12.623	1.026	.001	-1.011
	Seniors	173	11.799	1.818			23	13.634	.874		
BBD	Juniors	79	4.721	.445	.145*	-.101	24	5.100	.368	.006	-.313
	Seniors	173	4.822	.535			23	5.413	.380		
BBE	Juniors	79	6.916	.926	.001	.458	24	7.703	.444	.020	-.346
	Seniors	173	6.457	1.027			23	8.050	.541		
BBF	Juniors	79	11.628	1.154	.035	.410	24	12.807	.630	.002	-.655
	Seniors	173	11.218	1.527			23	13.463	.758		
FXD	Juniors	79	4.501	.445	.030	-.145	24	4.875	.344	.002	-.390
	Seniors	173	4.646	.509			23	5.265	.454		
FXE	Juniors	79	7.508	.644	.317*	.078	24	7.946	.405	.189*	-.157
	Seniors	173	7.429	.547			23	8.104	.401		
FXF	Juniors	79	12.005	.901	.915*	-.013	24	12.809	.602	.004	-.512
	Seniors	173	12.019	.914			23	13.321	.552		
FS	Juniors	79	47.629	3.831	.125*	-.840	24	51.661	1.918	.000	-3.058
	Seniors	173	48.470	4.111			23	54.719	1.799		

Table 4. T – test differences between disciplines expressed in points

Pair	Apparatus	Juniors n = 79			Seniors n = 173		
		M	SD	p	M	SD	p
Pair 1	VTF_2019 & UBF_2019	1.757	1.387	.000	1.587	1.498	.000
Pair 2	VTF_2019 & BBF_2019	1.249	.938	.000	2.168	1.305	.000
Pair 3	VTF_2019 & FXF_2019	.872	.725	.000	1.368	.813	.000
Pair 4	UBF_2019 & BBF_2019	-.508	1.288	.001	.581	1.577	.000
Pair 5	UBF_2019 & FXF_2019	-.884	1.238	.000	-.219	1.368	.037
Pair 6	BBF_2019 & FXF_2019	-.376	.844	.000	-.800	1.222	.000

Discussion

If we compare the age of the WAG by years we can conclude the increased complexity of COP in terms of DV and an increased number of deductions, according to need longer competitive internship to be successful in the gymnastics community (Atiković, Delaš Kalinski and Čuk, 2013[a]; Atiković, Delaš Kalinski and Čuk, 2013[b]). This means that learning new, more complex and more demanding elements is daily principle of training process which increases the length of training (Atiković, Delaš Kalinski and Čuk, 2013[b]). Atiković (2020) in his results show that the top female gymnasts chronological age increased to 4.02 years OG1996, (n = 105, M = 16.77, SD = 2.02); OG2000, (n = 97, M = 17.65, SD = 2.10); OG2004, (n = 98, M = 18.73, SD = 2.85); OG2008 (n = 97, M = 19.01, SD = 3.03); OG2012, (n = 96, M = 20.43, SD = 3.65); OG2016, (n = 98, M = 20.79, SD = 4.36). In the coming period, we do expect (with apparatus specialization) that age will rise. Changes in the General Rules and Code of Points by the Fédération Internationale de Gymnastique after 1997 years the trend is a significant change in the Olympic Games for WAG.

Gymnast like Simone Biles from (USA) is an amazing gymnast who continues to develop and challenge the norm WAG with creative and technical ability and skill. Biles on WCh 2019 in Stuttgart successfully performed on the Floor Exercise (FX) new element a triple double, which was given a J value. It's worth one point. Previously, the highest element value was I ($9/10^{th}$ of a point). Many athletes made their best results just in the years before the end of sports career. Nowadays, professional athletes are expected to leave sports after a certain age, but sometimes the reasons can be fooled. Namely, the average years of age have changed in the last 15 years (Atiković, Delaš Kalinski and Čuk, 2013[a]). The male gymnasts from 2003 to 2016 are on older for 2.3 years and female gymnasts for 3.3 years. In the forthcoming time, we

do expect (with apparatus specialization) that age will rise. Some gymnasts and gymnasts such as Oksana Chusovitina from (UZB) succeeding the age over 44 to be ranked high in major competitions. Oksana Chusovitina is competing at her eight Olympics 2021 year, another record, at the age of 46.13 year (Atiković, 2020).

It is possible to conclude that the field judging in artistic gymnastics extremely complex in every way. Most of the papers found focused on investigating the metric characteristics of judging, bias induced by the position in which female gymnasts appeared in their within-team order, biased judging for judges' own national team and against immediate competitors' teams, reliability and validity, equality between disciplines (Atiković and Smajlović, 2011; Ansorge et al., 1978; Ansorge and Scheer, 1988; Popović, 2000; Ste-Marie, Valiquette, & Taylor, 2001; Plessner and Schallies, 2005; Boen et al., 2008; Čuk and Atiković, 2009; Leskošek et al., 2010; Dallas and Kirialanis, 2010; Bučar Pajek et al., 2011; Bučar et al., 2012; Pajek et al., 2013; Heiniger and Mercier, 2018). In the present study author's, they were investigating the reliability and validity of judging at the ECh in Berlin 2011. In conclusion, the author's evaluated the quality of judging was comparable at examined gymnastics competitions of different levels. The author's emphasized that further work must be done to analyze the inferior results at VT and FX apparatuses (Bučar et al., 2011; Bučar et al., 2012; Pajek et al., 2013). This interesting study dealt with the predictors of success with spectators to serve as a judge and showed interesting results (Čuk, 2015). The reliability of exercise presentation judging is the same as for official judges; ranking is analogous to the official judges and even higher. The analysis has allocated three groups of fans – strict, medium and permissive. With modern technology, e.g. smart mobile phones FIG could perform some experimental judging among fans.

In the past, author's (Fink, 1986; 1991; Fink and Fetzer, 1991) suggested multiplying exercise presentation by D score, but it was never implemented in the official FIG competitions. The ideal or preferred system for final score calculation is a matter of political decisions. From a historical overview many different ways of calculating the final score were used to evaluate gymnastics. Author's (Čuk, Fink and Leskošek, 2012) compared 14 different models for calculating the final scores. According to the simplicity of the VT (comparing to other disciplines, not stating vault is easy!). Those who VT well have the possibility of a higher final score of all-around. Vault is according to the analysis of the training loads also discipline with the lowest amount of time spent (Čuk and Karacsony, 2004). It probably makes the control of balance more difficult when executing elements on balance beam, which results in more frequent errors and, finally, in lower execution scores (Erceg, Delaš Kalinski and Milić, 2014).

After the analysis seniors results individual qualification WCh 2019 in the Stuttgart (GER) it is clear that individual groups and types of jumps are more represented than others. We can see that there are (n = 207) seniors and (n = 108) juniors gymnasts in the qualifications. The most represented are from a group (gr.) 4: 144 (70%), followed by group 2: 31 (15%) and group 3: 27 (13%). Even 86 gymnasts had start value 4.60 points (41.7%), 36 gymnasts had start value 5.40 points (17.5%) and 16 gymnasts with 5.00 points (7.8%). After the analysis juniors results WCh 2019 in the Gyor (HUN) we can see that there are even 43 gymnasts had start value 4.60 points (42.0%), 13 gymnasts had start value 3.50 points (12.1%) and 10 gymnasts with 5.40 points (9.3%).

If we compare the seniors results a little better in all - around qualification WCh 2019 in the Stuttgart (GER) we can see that there are (n = 173) seniors and (n = 79) juniors gymnasts in the qualifications. Even 75 gymnasts had start value start value 4.60 points (43.4%), 29 gymnasts had start value 5.40 points (9.2%). After the analysis juniors results WCh 2019 in the Gyor (HUN) we can see that there are even 29 gymnasts had start value 4.60 points (36.7%), 10 gymnasts had start value 4.00 points (12.7%). The most abundant vault during the individual and all – around qualifying period was the jump number 4.32 or terminology name: "*Round-off, flic-flac on – stretched salto bwd with 1/1 turn (360 °) off*" with 4.60 points.

Factor analysis extracted one significant factors have quite similar explained variance (73.2% the first factor juniors, 68.9% the first factor seniors). As a conclusion we can say disciplines are equal. Factor analysis in men's artistic gymnastics showed 3 factors ten years ago with 67% or 26% the first factor, 22% the second factor and 19% the third factor. Gymnasts have the highest D score values on vault. According to simplicity of the vault (comparing to other disciplines, not stating vault is easy!) those who vault good have possibility of higher final score of all around (Čuk and Atiković, 2009).

The findings of the present study confirmed the hypothesis that senior women gymnasts achieve significantly higher numerical values than junior women gymnasts in 3 individual apparatus, teams competition and all-around event except routine FXF and in the final score FS. It can be said that in the individual apparatus qualifying competition there is no difference between junior and senior FXF. There are no statistically significant differences in individual competitions at final score of BBF and FXF finals.

What is very interesting is that there are no statistically significant differences in the women's all-around qualifications FXF and final score FS. There is no difference in the start value on the BBD between junior and senior in qualifications. However, there is a difference in the finals competitions 24 of the best gymnast. Comparison of

the results has attracted attention on the vault, which differ by more than one point than other disciplines.

Conclusion

Coaches can use results from this research for planing of preparation tactics of gymnasts for all around, team and apparatus competition. On the basis of what was presented in the work, the importance of the permanent identification of how to reach the maximum potential, how to determine team competition strategy, should we strive for the balanced development of all disciplines, which disciplines have the most positive transfer to other disciplines, what disciplines are most contributing to the success in all-around?

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